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55:4 Part II (Winter 2016) pp. 947–953

Hold-up Problem in Price Cap Regulation with Limited Ability of Commitment in High Inflation

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In this study, we examine the hold-up problem under price cap regulation in developing economies characterised by high inflation that have a limited ability to commit. The governments of developing countries are unable to modify the exact inflation rate. If high inflation is brought about by unexpected monetary expansion after the initial average price is fixed, the insufficient ability to show exact inflation causes a lack of commitment to adjust the initial fixed price to the modified price. The study's findings show that those that have a limited ability to commit cause a hold-up problem if inflation is sufficiently high for a firm to stop production at the initial price, while the hold-up problem does not occur if inflation is lower and the initial fixed price generates a sufficient profit for the first-best investment for the firm.

JEL Classification: D86, L14, L43,L51
Keywords: Price Cap Regulation, Hold-up Problem, Limited Ability of Commitment, Inflation Adjustment

1. INTRODUCTION

Jean-Jacques Laffont's seminal work "Regulation and Development" [2005] modified the optimal incentive regulation of developed countries to be appropriate for developing countries, whose governments have only a limited ability in various aspects. Laffont's work has garnered increasing attention, especially in the study of developing economies and economics of regulation.

In this study, we examine the hold-up problem in the case of price cap regulation for economies that have a limited ability to commit (i.e., they are unable to modify the exact inflation rate). Price cap regulation is a commitment to fix the price of a regulated firm at the initial level with some adjustment based on inflation. It thus provides an incentive for the regulated firm to reduce its cost of production. By contrast, average cost pricing does not provide any incentive to reduce costs because it is allows firms to raise prices ex-post whenever costs exceed prices. Average cost pricing is easy to calculate and there is no need to commit to an initial price.

Of these two cost approaches, price cap regulation is preferable for providing

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Author's Note: This work was supported by JSPS KAKENHI Grant Numbers 15K00473 and 24330064. I thank the participants of the Contract Theory Workshop East, Hitotsubashi University, the Korea Economy and Business Association, and the session on Economic Policies of Development at the 31st PSDE conference.

regulated firms with an incentive to reduce costs. However, price cap regulation might be difficult for developing countries to commit to and adjust because of the limited abilities of their governments to calculate an adequate inflation rate. In these cases, the hold-up problem might occur and a regulated firm's investment may decrease.

If high inflation is brought about by unexpected monetary expansion after the initial price is fixed, the above-mentioned limited ability of the government causes a lack of adjustment from the initial fixed price to the modified price. This study shows that such a limited ability to commit causes a hold-up problem if inflation is sufficiently high for the firm not to afford the initial price, while the hold-up problem does not occur if inflation is lower because the initial fixed price generates sufficient profit for first-best investment for the firm.

The present research is based on incomplete contract theory introduced by Grossman and Hart (1986) and Hart Moore's [1990] seminal work on the property rights approach[1], while our model is a simplified version of Edlin and Reichelstein (1996). They consider whether the first-best outcome is achieved in a typical buyer/seller model of incomplete contracts and show that fixed price contracts bring about the first-best investment. In our model, however, we deal with the case that the nominal term deviates from the real term because of unexpected inflation. The government authorities cannot verify the difference between the real change and nominal change of the cost facing unexpected inflation. Thus, a fixed price contract does not work and the hold-up problem occurs.

Nominal consideration in the incomplete contract literature was introduced by Jovanovic and Ueda (1997), based on Aghion, Dewatripont, and Rey (1994). These studies give the possibility of renegotiation design and lead to the first-best outcome. Our model, however, does not allow it and the hold-up problem occurs.

To our knowledge, this is the first study of limited commitment by the government leading to the hold-up problem, as pointed out in Laffont (2005) and Estache and Wren-Lewis (2009). The remainder of the paper is organised as follows. In the next section, we present the model, and we derive the results in Section 3. Section 4 offers concluding remarks.

2. THE MODEL

A natural monopoly firm produces good X, and the average cost in the initial period is C. We assume that C and the initial price are verifiable. Thus, without inflation, price cap regulation works and the optimal effort can be derived. If unexpected inflation occurs, on the contrary, the government authorities cannot verify the difference between the real change and nominal change of the cost and therefore the hold-up problem may occur.

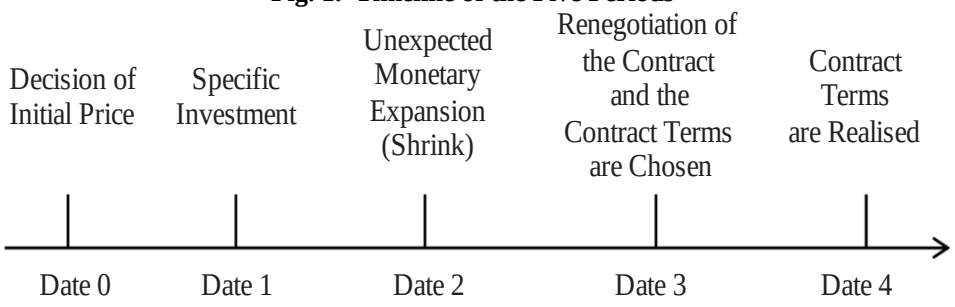
The government regulator regulates the monopoly firm by adopting price cap regulation. It tries to fix the price as low as possible and decrease the deadweight loss of the market caused by the monopoly. The monopoly firm, on the contrary, maximises profit subject to the regulation.

We develop the simplified model derived by Edlin and Reichelstein (1996), in which only the regulated firm invests ex-ante. Thereafter, unexpected monetary

[1]See Hart [1995].

expansion causes unexpected inflation. There are five periods (see Figure 1). At time zero, the regulator sets price *P*. Based on price cap regulation, *P* is fixed with an average cost of the monopoly firm of *C*, which is verifiable and should be fixed except for an inflation adjustment.

Fig. 1. Timeline of the Five Periods



At time one, the central bank decides monetary expansion *M*, which is assumed to be exogenous for the government. The monetary expansion causes future inflation, the rate of which is τ.

It should be noted that specific price regulation except the initial cost at time zero cannot be realised, because the inflation rate is uncertain at time zero and because the government cannot discriminate the inflation and real shocks in terms of the increase in the cost. Thus, a simple contract with a specific price, as proposed by Edlin and Reichelstein (1996), cannot achieve the first-best outcome. We also assume that a contract with the real term cannot be used because the resale price of the goods produced by the regulated firm should be written in nominal terms.

The real interest rate is assumed to be zero and the discount factor is 1. Even if the real interest rate is normalised to zero, we must consider the nominal interest rate with inflation rate τ.

At time two, the monopoly firm makes a specific investment *e*, which reduces cost *C* and the reduced cost is *C*–*e*. The cost of investment is $\psi(e)$, which is assumed to be $\psi' > 0$, $\psi'' > 0$. Moreover, both the investment and the cost of investment are unverifiable. Although the real interest rate is assumed to be zero, the nominal interest rate is equal to the inflation rate τ. We thus consider the case that it takes one period to realise the investment after it has been make. Then, the firm considers the inflation rate brought about by the specific investment as $(1 + \tau)\psi(e)$ instead of $\psi(e)$.

In developed countries, it is easy to verify τ. In some developing countries, on the contrary, this might be difficult to calculate in order to justify the exact inflation rate. We assume τ is unverifiable in our model. We also assume that the inflation rate cannot be verified even ex-post. This might cause both the monopoly firm and the government to renegotiate the regulated price ex-post after the inflation rate has been realised.

At time three, inflation rate τ is revealed and renegotiation might occur. We specify the bargaining procedure and government objectives. The government maximises consumer welfare when the firm produces the goods. Consumer welfare is assumed to be *W*.

We assume that the regulated firm and government divide the outcome based on α:1–α according to extended Nash bargaining, ensuring zero profit to the firm. The cost reduction of the firm is e. Thus, the outcome of the renegotiation is $W+e$. The parties then renegotiate that with the zero profit condition of the firm.

At time four, the regulator should adjust the regulated price according to the results of the renegotiation. Then, the transaction takes place.

3. FIRST-BEST AND EQUILIBRIUM OUTCOMES

In this section, we derive the equilibrium behaviour and ex-ante investment by the regulated firm. First, we derive the first-best outcome in which τ is verifiable. By adjusting inflation rate τ, the estimated regulated price is $\hat{P} = (1+t)C$. If the government can commit to adjust inflation, the firm maximises the following equation by e:

$$\hat{P} - (1+\tau)C - e - (1+t)\psi(e) = e - (1+t)\psi(e)$$

The first-order condition is as follows:

$$1-(1+t)\psi'(e) = 0$$

This provides the optimal investment level $\hat{e}$.

Next, we turn to the case that τ, e, and the costs, ψ, are unverifiable. Owing to the limited ability of the government, it cannot calculate the exact inflation rate τ. Further, if the regulated firm acquires the profit at initial price P, the regulatory authority has no incentive to renegotiate. Thus, the regulator adopts initial price P even if inflation occurs, unless it is not so large. If the inflation rate is large, however, the firm no longer enjoys the positive benefit from initial price P. This stops production, and hence both parties have an incentive to renegotiate, which causes a hold-up problem. First, we derive the condition that there is no renegotiation. We derive the following proposition.

Proposition 1: ***Investment Level with Lower Inflation***

Although inflation is unverifiable, if inflation is less than $\hat{\tau}$, the hold-up problem does not occur and the first-best ex-ante investment is achieved.

$$\tau \le \hat{\tau} = \frac{\hat{e} - \psi(\hat{e})}{C + \psi(\hat{e})} \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad (1)$$

Proof If (1) holds, the monopoly firm's maximisation problem ex-ante is the following equation:

$$max_e P - (1+\tau)C + e - (1+t)\psi(e)$$
$$= e - (1+t)\psi(e) - tC$$

If $\hat{e} - (1+t)\psi(\hat{e}) - tC > 0$, that is, $\tau \le \hat{\tau}$, then the firm makes the optimal investment and production. (Q.E.D.)

Now, we turn to the case with higher inflation such as

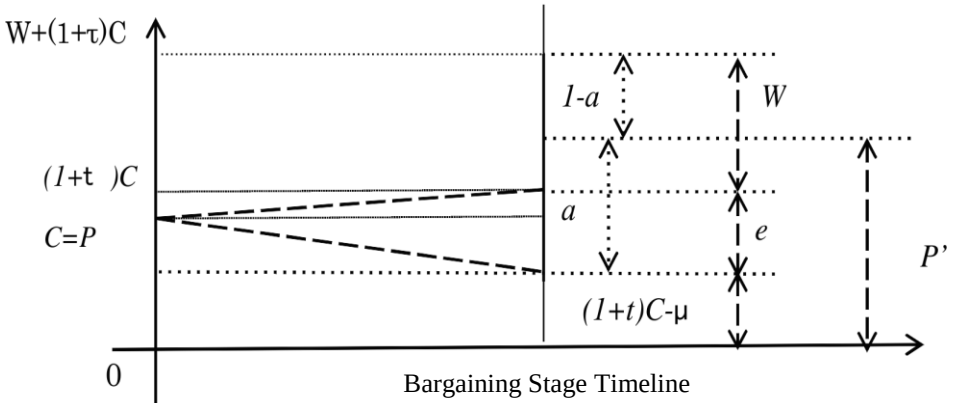
$$\tau > \hat{\tau} = \frac{\hat{e} - \psi(\hat{e})}{C + \psi(\hat{e})} \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad (2)$$

Renegotiation takes place because the firm stops production at the initial price unless the revenue exceeds C–e. Thus, the government must ensure that the firm generates the revenue at the lowest break-even level ex-post.

Based on extended Nash bargaining, both parties receive a share of the surplus $W + e$ with α, $1-\alpha$. Thus, the regulated firm receives the surplus $\alpha(W+e)$, while the government has the surplus $(1-\alpha)(W+e)$. Thus, the surplus must be added to the cost to produce the good, $(1+\tau)C-e$ (see Figure 2). Thus, renegotiated price P'' is as follows:

$$P' = \alpha(W+\mu) + (1+\tau)C - e$$

Fig. 2. Illustration of the Renegotiation Surplus from t=0 to t=3



The firm maximises the following equation by e with regulated price P':

$$\begin{aligned} & P' - (1+\tau)C + e - (1+\tau)\psi(e) \\ &= \alpha(W+e) + (1+t)C - e - ((1+t)C - e) - (1+\tau)\psi(e) \\ &= \alpha(W+e) - (1+\tau)\psi(e) \end{aligned}$$

By solving the first-order condition, we derive e^*, which is lower than $\hat{e}$ of the first-best outcome. This lower investment is caused by the hold-up problem with higher inflation. Interestingly, without perfect bargaining power by the monopoly firm, α=1, the hold-up problem will occur even if the renegotiated price is higher than the optimal adjusted price, $P' > \hat{P} = (1+t)P$. We sum up the results in the following proposition.

Proposition 2: ***Hold-up Problem with Higher Inflation*** If $\tau > \hat{\tau}$, renegotiation and thus hold-ups occur. Even if the renegotiated price is larger than the optimal adjusted price, $P' > \hat{P}$, the hold-up problem occurs and this leads to less specific investment, $\hat{e} > e*$, unless α=1.

Proof If $\tau > \hat{\tau}$, renegotiation and thus hold-ups occur. Then, the firm maximises the following:

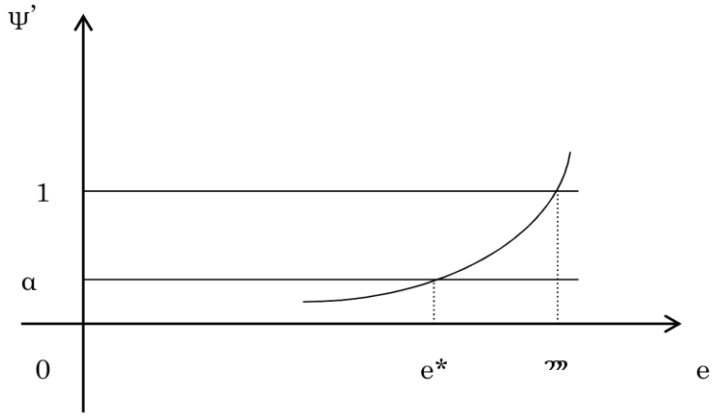
$$P' - (1+\tau)C + e - (1+t)\psi(e)) = \alpha(W+e) - (1+t)\psi(e) \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Hence, the first-order condition is as follows:

$$\alpha - (1+t)\psi'(e) = 0$$

Here, $\alpha<1$ means lower investment than that at the optimal level, as shown in Figure 3.

Fig. 3. Hold-up Problem and the Underinvestment of the Firm



Consequently, higher inflation causes the hold-up problem in developing countries that have a limited ability to commit. In addition, higher inflation raises the adjustment price above the level of the optimal adjustment price.

4. CONCLUDING REMARKS

In this study, we showed theoretically that a limited ability to commit causes the hold-up problem and decreases investment as a result of renegotiation. In particular, the hold-up problem for a regulated monopoly firm occurs under price cap regulation if the government cannot specify the inflation rate accurately and the inflation rate is high. We also show that although the government cannot specify the inflation rate accurately, the first-best outcome can be achieved if inflation is sufficiently low.

In summary, higher inflation causes the hold-up problem in developing countries that have a limited ability to commit. In addition, it causes a higher price than the optimal adjustment price.

We conclude by discussing a limitation of the model. In this model, we abstracted the uncertainty. However, the research could be extended to include using a model with uncertainty, and we could prove the robustness of the results explicitly. Building an explicit model with uncertainly, in this regard is thus a possible future research direction.

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